



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : <b>E21B 43/08, 43/10</b>	<b>A2</b>	(11) International Publication Number: <b>WO 00/08301</b> (43) International Publication Date: 17 February 2000 (17.02.00)
(21) International Application Number: <b>PCT/GB99/02605</b> (22) International Filing Date: 9 August 1999 (09.08.99) (30) Priority Data: 9817246.3                      8 August 1998 (08.08.98) <b>GB</b> (71) Applicant (for all designated States except US): <b>PETROLINE WELLSYSTEMS LIMITED (GB/GB); Offshore Technology Park, Claymore Drive, Bridge of Don, Aberdeen AB23 8GD (GB).</b> (72) Inventor; and (75) Inventor/Applicant (for US only): <b>METCALFE, Paul, David (GB/GB); North Wing, Bucklerburn Steading, Peterculter AB14 0NP (GB).</b> (74) Agents: <b>MCCALLUM, William, Potter et al.; Cruikshank &amp; Fairweather, 19 Royal Exchange Square, Glasgow G1 3AE (GB).</b>	(81) Designated States: <b>AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW.</b> ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  Published Without international search report and to be republished upon receipt of that report.	
(54) Title: <b>CONNECTOR FOR EXPANDABLE WELL SCREEN</b>  <div data-bbox="438 1050 1234 1302"> </div> (57) Abstract  A tubing connection arrangement (10) comprises two expandable tubing sections (12, 14), each tubing section comprising a filter screen (16, 18) sandwiched between inner expandable tubing (20, 22) and outer expandable tubing (24, 26). The filter screen of one tubing section overlaps the filter screen of the other tubing section and the outer expandable tubing of at least one of the tubing sections extends over the overlapping filter screens. On expansion of the tubing sections, the overlapping filter screens, restrained by the outer tubing, ensure the integrity of the filter between the tubing sections.		

BEST AVAILABLE COPY

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## CONNECTOR FOR EXPANDABLE WELL SCREEN

This invention relates to a downhole connector, and in particular to an arrangement for ensuring the integrity of a sand screen or other filter medium at a connection between two lengths of expandable tubing utilised to support or form a sand screen or filter.

In many well bores where a liquid, for example oil, passes from a surrounding formation into the well bore, the liquid will often carry entrained sand particles. If this sand is permitted to pass into the well bore a number of problems may arise, including an increased likelihood of the well bore becoming blocked or restricted, and the sand may cause downhole tools to stick or jam, or wear prematurely. Accordingly, it is preferred that the sand particles are retained in the formation. This is achieved by providing screens or a filter around the casing or production tubing.

International Patent Application WO 97/17524 (Shell), the disclosure of which is incorporated herein by reference, describes a radially expandable assembly in which overlapping filter sheets are sandwiched between inner expandable support tubing and outer expandable protective tubing, the expandable tubing featuring large numbers of overlapping longitudinal slots. When an expander cone is forced through the assembly, the inner and outer tubing is expanded radially, the slots extending to form diamond-shaped openings. The initial degree of overlap between the screens is selected such that,

although the screens move circumferentially relative to one another during expansion, the edges of the screens remain in overlapping relation. Such an arrangement can easily be constructed over sections of plain tubing or pipe. However,  
5 at the connections between tubing sections, where the inner tubing sections are coupled together, it is difficult to maintain a "sand-tight" join.

It is among the objectives of embodiments of the present invention to provide a connector arrangement which obviates  
10 or mitigates this difficulty.

According to the present invention there is provided a connector arrangement for provision between the ends of two sections of expandable tubing, each expandable tubing section comprising a filter screen sandwiched between inner  
15 expandable tubing and outer expandable tubing, the filter screen of one tubing section overlapping the filter screen of the other tubing section and the outer expandable tubing of at least one of the tubing sections extending over the overlapping filter screens.

20 The invention also relates to expandable tubing sections which are adapted to be connected in this manner, and to expandable tubing strings incorporating such connector arrangements, and to a method of connecting tubing sections.

On expansion of the tubing sections, the overlapping  
25 filter screens, restrained by the outer tubing, ensure the integrity of the filter between the tubing sections.

The outer expandable tubing of one tubing section may be arranged to overlap or to butt against the outer expandable

tubing of the other tubing section.

Each filter screen will typically comprise a plurality of overlapping plates, sheets or membranes individually mounted to the respective inner expandable tubing by axially  
5 parallel connectors or fixings, such as screws, lugs or welds.

Preferably, the filter screens of each tubing section are initially radially spaced apart to facilitate make-up of the connector. However, on expansion, the resistance of the  
10 outer tubing to radial expansion of the inner tubing ensures that the outer filter screen is pressed into sand-tight engagement with the inner filter screen. The desired relative positioning of the filter screens of the two tubing sections may be achieved by providing one inner tubing  
15 section having an end of slightly larger diameter than the other. In certain embodiments the ends of each tubing section may be upset, that is of greater diameter than the remainder of the tubing section, and the desired difference in diameter may be achieved by providing a slightly higher  
20 upset on one tubing section. Conveniently, the inner tubing sections will feature pin and box connections, and the upset on the box may be slightly higher than the pin. Of course the opposite arrangement may be provided, that is the pin upset being higher than the box.

25 The ends of one or both filter screens may be provided with means for preventing interference between the screen ends when the tubing sections are rotated relative to one another, as may be the case if the tubing sections are

threaded to one another. Said means may take the form of a sleeve of flexible or extendible material located internally and/or externally of the filter screens. The sleeve may be formed of flexible slotted tubing, plastics, rubber, wire mesh or wire composites.

According to another aspect of the present invention there is provided a section of expandable tubing comprising a filter medium sandwiched between inner expandable tubing and outer expandable tubing, the filter medium comprising a plurality of circumferentially extending filter sheets, each sheet being coupled at one edge to one of the inner and outer tubing and having the opposite edge overlapping an adjacent sheet, and means for reducing the friction between at least one of the filter sheets and the filter sheets and the tubing.

In other aspects of the invention friction reducing means may be provided on other parts or elements of a tubing section.

This aspect of the invention may be provided in combination with the first described aspect.

In use, the friction reducing means facilitates expansion of the tubing by facilitating relative circumferential movement of the filter sheets relative to one another and of the filter sheets relative to the tubing. The presence of such friction reducing means also reduces the likelihood of damage occurring to the relatively fragile filter sheets during expansion, as has been found to occur on occasion in tubing made in accordance with WO 97/17524.

Preferably, the friction reducing means is a low.

friction coating applied to the filter sheets, such as a PTFE-based material such as Teflon (trade mark). In other embodiments a friction-reducing lubricant, such as high temperature grease, may be provided. Alternatively, sheets  
5 of low friction material may be placed between the filter sheets and the tubing.

These and other aspects of the present invention will now be described, by way or example, with reference to the accompanying drawings, in which:

10 Figure 1 is a schematic sectional view of part of a connector in accordance with a preferred embodiment of the present invention, with the connector parts shown separated; and

15 Figure 2 is a schematic sectional view of the connector of Figure 1, with the connector parts shown coupled together.

The drawings illustrate part of a connector 10 in accordance with an embodiment of the present invention. The connector 10 is provided between the ends of two sections of expandable tubing 12, 14, each comprising filter plates 16,  
20 18 sandwiched between inner expandable support tubing 20, 22 and outer expandable protective tubing 24, 26. Each section of expandable tubing 20, 22, 24, 26 defines a large number of longitudinal overlapping slots. The sections of inner or base expandable tubing 20, 22 are formed with co-operating  
25 pin and box connections 28, 30, to allow the tubing sections 12, 14 to be made up by relative rotation.

As is more clearly apparent from Figure 2, the box connection 30 is upset from the pin 28. The filter plates 18

---

mounted around the box 30 extend beyond the end of the box outer surface 32 such that on making up the connection the filter plates 18 overlap the filter plates 16 mounted on the pin 28. The outer tubing 24 on the pin 28 terminates short of  
5 the end of the filter plates 16 to accommodate the filter plate overlap, and the outer tubing 24 is similarly overlapped by the end of the outer tubing 26 on the box 30.

The overlapping filter plates 16, 18 are positioned such that there is a small radial gap G between the filter plates  
10 16, 18, to allow the connection to be made up without snagging or galling of the opposing filter plates.

When the connection is expanded downhole, by passing a cone through the connection, the outer tubing 24, 26 resists the expansion of the inner tubing 20, 22. This results in the  
15 outer tubing 24, 26 providing an inward radial force which maintains the overlapping filter plates 16, 18 in engagement and effects a sand-tight seal.

To facilitate make-up and backing-off of the connection  
10, the ends of the filter plates 16 are provided with an expandable make-up protection sleeve 32 which prevents the  
20 overlapping plates on either the pin 28 or the box 30 from snagging on the opposing filter plates when the pin and box are rotated relative to one another.

To facilitate expansion of the tubing, the filter plates  
25 16, 18 are provided with a coating 34 of a low-friction material, in this case a PTFE-based material such as Teflon. This coating facilitates relative movement of the plates 16, 18, and relative movement of the plates 16, 18 and the tubing



20, 22, 24, 26, and minimises the risk of tearing of the filter plates 16, 18 as the tubing sections are made up and expanded.

5 It will be clear to those of skill in the art that the above-described embodiment is merely exemplary of the present invention, and that various modifications and improvements may be made thereto without departing from the scope of the present invention.

**CLAIMS**

1. A tubing connection arrangement comprising two expandable tubing sections, each tubing section comprising a filter screen sandwiched between inner expandable tubing and outer expandable tubing, the filter screen of one tubing section overlapping the filter screen of the other tubing section and the outer expandable tubing of at least one of the tubing sections extending over the overlapping filter screens.
2. The arrangement of claim 1, wherein the outer expandable tubing of one tubing section is arranged to overlap the outer expandable tubing of the other tubing section.
3. The arrangement of claim 1, wherein the outer expandable tubing of one tubing section is arranged to butt against the outer expandable tubing of the other tubing section.
4. The arrangement of any of claims 1, 2 or 3, wherein each filter screen comprises a plurality of overlapping sheets individually mounted to the respective inner expandable tubing by axially parallel fixings.
5. The arrangement of any of the preceding claims, wherein the filter screen of one tubing section is initially of greater diameter than the filter screen of the other tubing

section such that the filter screens are initially radially spaced apart.

5 6. The arrangement of claim 5, wherein the inner tubing of said one tubing section has an end of larger diameter than the end of the inner tubing of the other tubing section.

7. The arrangement of claim 6, wherein the ends of at least one tubing section is upset.

10 8. The arrangement of claim 7, wherein the ends of both tubing sections are upset, with a higher upset being provided on one tubing section.

9. The arrangement of claim 7 or 8, wherein the inner tubing sections incorporate pin and box connections, and the upset on the box is higher than the upset on the pin.

15 10. The arrangement of any of the preceding claims, wherein the end of at least one filter screen is provided with means for preventing interference between the screen ends when the tubing sections are rotated relative to one another.

11. The arrangement of claim 10, wherein said means for preventing interference is a sleeve of extendible material.

20 12. The arrangement of claim 11, wherein the sleeve extends internally of at least one of the filter screens.

13. The arrangement of claim 11 or 12, wherein the sleeve extends externally of at least one of the filter screens.

14. The arrangement of any of the preceding claims, wherein the filter screen comprises a plurality of circumferentially extending filter sheets, each sheet being coupled at one edge to one of the inner and outer tubing and having the opposite edge overlapping an adjacent sheet, and means for reducing the friction between at least one of the filter sheets and the filter sheets and the tubing.

15. A tubing connection method comprising:  
providing at least two expandable tubing sections, each tubing section comprising a filter screen sandwiched between inner expandable tubing and outer expandable tubing; and  
connecting ends of the tubing sections such that the filter screen of one tubing section overlaps the filter screen of the other tubing section and the outer expandable tubing of at least one of the tubing sections extends over the overlapping filter screens.

16. A section of expandable tubing comprising a filter medium sandwiched between inner expandable tubing and outer expandable tubing, the filter medium comprising a plurality of circumferentially extending filter sheets, each sheet being coupled at one edge to one of the inner and outer tubing and having the opposite edge overlapping an adjacent sheet, and means for reducing the friction between at least one of

the filter sheets and the tubing.

17. The tubing of claim 16, wherein the friction reducing means is a low friction coating applied to the filter sheets.

1/1

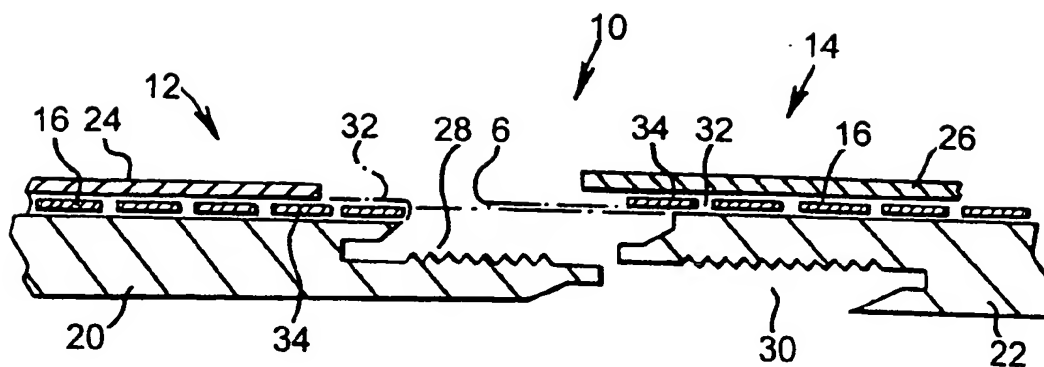


Fig. 1

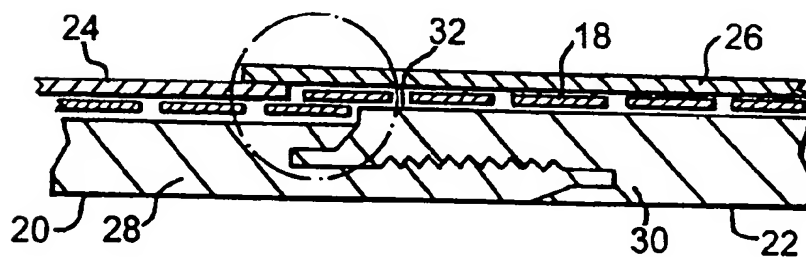


Fig. 2

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☒ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**